



SHORT COMMUNICATION

Effect of Pellet Diameter on Physical Characteristics and Intake of Concentrate Pellet in Goats

Ravindra Kumar^{1*}, Arvind Kumar¹, Anjali Sudhakar², S.K. Chakraborty²
and Dori Lal Gupta¹

Division of Animal Nutrition Management and Product Technology,
ICAR-Central Institute for Research on Goats, Makhdoom, Farah, Mathura-281122, India

ABSTRACT

This experiment was conducted to study the effect of pellet size on feed intake in goats. Three types of concentrate pellet of same composition (bulk density, 0.614 g/cm³) was prepared using different pellet die (8 mm, 10 mm and 12 mm) size at the feed pelleting unit of Animal Nutrition Experimental shed, ICAR-Central Institute for Research on Goats, Makhdoom. The physical properties of pellet like sectional expansion index (SEI), longitudinal expansion index (LEI), water absorption index (WAI) and cutting strength (CS) was similar in all type of pellets. Volumetric expansion index (VEI) increased while specific length (mm/g), specific gravity (g/cc) and bulk density (g/cm³) decreased with increase in the pellet die diameter. Water solubility index (WSI%) was similar in 8 mm (10.02) and 10 mm (10.22) pellet but reduced in 12 mm (9.74) pellet. Feeding trial was conducted in male goats (Age 1 year with mean body weight 23.84 kg) to study the impact of pellet diameter on feed intake and behaviour of animals. Twelve adult goats were divided into three groups (Gr I, Gr II and Gr III) of four each and fed with 8 mm, 10 mm and 12 mm pellet, respectively. Animals were fed with concentrate pellet at the rate of 1.5 % of live body weight and arhar straw *ad libitum*. During 1st week of feeding the consumption time (min) of pellet was significantly ($P < 0.05$) higher in Gr III (21.46) followed by Gr I (16.10) and Gr II (13.57). After that no significant difference was reported in consumption time of different concentrate pellet in goats. Overall, there was no impact of pellet diameter on the pellet intake and feed intake in goats. Present study concluded that goat can adopt for the intake of pellet of different diameter and feed intake was not affected by pellet diameter.

Key words: Goats, Feed intake, Pellet diameter, Physical properties

Goats are predominantly being reared on community pastures under grazing system with little supplementation during productive phase of life. But due to unavailability of grazing land and pressure of urbanization the system of goat rearing is changing to intensive system. Semi intensive and intensive system of goat production are suitable in urban and peri-urban locations where higher returns from goat products is expected. In the light of this, use of concentrate mixture, high energy high protein ingredients in the ration of goat is required to meet the nutrient need of goat. Use of concentrate in the form of pellet has many advantages as compared to mash. Pellet form of feed provides synchronized nutrient in the rumen with higher nutrient use efficiency for production functions.

Processing of concentrate mixture in the form of pellet reduces the bulkiness of the feed resources, reduces feed wastages, improves storage, transportation and keeping quality. In case of poultry, effect of pelleting and pellet size has been studied extensively. In case of broiler, pelleting had been found to improve feed efficiency and growth response without increasing metabolisable energy content per unit of feed (Sibbald and Wolynetz, 1989; Cutlip *et al.*, 2008). The positive effect of pelleting on feed efficiency is due partly to a marked increase in feed intake and the reduction in energy spent on feed ingestion. Thus, pelleting improves the productive energy content of the feed (Reddy *et al.*, 1962; Jensen, 2000). Die diameter can affect the physical property of pellet and its intake in animals. So,

*Corresponding Author: Email: ravindra.srivastava@gmail.com; ravindra.kumar@icar.gov.in; Division of Animal Nutrition Management and Product Technology; ICAR-Central Institute for Research on Goats, Makhdoom, Farah, Mathura-281122; ²ICAR-Central Institute of Agriculture Engineering, Bhopal, MP, India

a suitable die size most suited for goats pellet need to be established. This pellet size can be utilised by feed manufacturing unit for commercial goat feed production. With this background, this study was conducted to evaluate the concentrate pellet of different diameter on physical characteristics and its effect on intake in goats.

The present study was conducted at Animal Nutrition Management and Product Technology Division of ICAR-Central Institute for Research on Goats, Makhdoom, Farah, Mathura India. Geographically, the institute is located at 27° N latitude, and 78° N E longitude on 176 m above the sea level. Three types of concentrate pellet of same composition was prepared using different die size at the feed pelleting unit of the Institute. The concentrate mixture was containing 55% rushed barley (*Hordeum vulgare*), 25% linseed (*Linum usitatissimum*) cake, 17% wheat (*Triticum aestivum*) bran, 2% mineral mixture and 1 % salt. This mixture was passed through the die of different size (8 mm, 10 mm, and 12 mm) in pellet making machine purchased from Kiran Engineering, Batala, Punjab. The bulk density of this concentrate mixture was estimated by sand displacement method and was found to be 0.614g/cm³.

The physical properties of 3 feed pellets, made with same ingredients using pellet die of diameter 8 (S1), 10 (S2) and 12 (S3) mm respectively were studied at ICAR-Central Institute of Agricultural Engineering, Bhopal. Sand displacement method was used for estimation of bulk density (BD) and texture analyser settings were used for estimation of cutting strength (CS). Test was conducted in compression mode with pre-test speed of 5 mm/s, test speed 1 mm/s and post-test speed of 10 mm/s. Trigger force of 50 g was used in auto mode. Random samples were selected from the pelleted mass and the width of feed pellet was measured using screw gauge. The sectional expansion index (SEI) was estimated as the ratio of diameter of prepared feed pellet to the diameter of the die used for making pellets. Specific length (SL) was calculated as per the definition given by Alvarez-Martinez *et al.* (1988).

$$\text{Specific length (mm)} = \frac{\text{Length of specimen (mm)}}{\text{Weight of specimen (g)}}$$

Bulk density (BD) of the pellet was determined by sand displacement method. The moisture content of the prepared pellet was measured by keeping the product in hot air oven for 18 h at 80°C and the weight of the pellet material was found out after deduction of weight of moisture. The ratio of sample weight and the displaced volume in the cylinder was calculated as density (w/v). BD indicates the expansion ratio in describing the degree of puffing in extrudes. The force-distance plot of the texture analyser peaks at a particular point which is taken as the cutting strength (CS), (Garg, 2005). The peak is followed by a steep fall over the force axis, which shows that the product has been cut.

Water absorption index (WAI) indicates the amount of water immobilised by the extrudate, while water solubility index (WSI) indicates the amount of small molecules solubilised in water. The ground pellet ingredients were suspended in water at room temperature and stirred gently during this period, then centrifuged at 3000× g for 15 min. The supernatants were decanted into an evaporating dish of known weight. The WAI was the weight of gel obtained after removal of the supernatant per unit weight of original dry solids. The WSI was the weight of dry solids in the supernatant expressed as a percentage of the original weight of sample.

Water solubility index (%) =

$$\frac{\text{Weight of dry solids in supernatant (g)} \times 100}{\text{Dry weight of extrudate (g)}}$$

Feeding trial was conducted in male Barbari goats (Age 1 year with mean body weight of 23.84 kg) to study the impact of pellet diameter on intake and feeding behaviour of animals. Twelve adult animals were allocated into three groups (Gr I, Gr II and Gr III) of four each and fed pellets having diameter of either 8 mm, 10 mm and 12 mm, respectively. Each animal was first fed with concentrate pellet at the rate of 1.5% of body weight and time to consume the pellet was recorded using stop watch. After that gram straw was offered to the animal. Next morning the refusal of gram straw was weighed and a sample was collected for DM estimation. Total intake of the animal was calculated as

Table 1. Physical characteristics of concentrate pellets of different diameter

Physical Characteristics	Pellet		
	S1(8 mm)	S2(10 mm)	S3(12 mm)
Sectional expansion index	1.14±0.01	1.16±0.02	1.17±0.02
Longitudinal expansion index	0.095±0.0	0.095±0.0	0.079±0.0
Volumetric expansion index	0.40±0.002 ^a	0.51±0.003 ^b	0.51±0.003 ^b
Specific length (mm/g)	12.10±0.06 ^a	9.54±0.06 ^b	6.56±0.03 ^c
Specific gravity (g/cc)	1.45±0.008 ^a	1.15±0.007 ^b	1.15±0.008 ^b
Bulk density (g/cc)	1.17±0.04 ^a	0.96±0.03 ^b	0.79±0.02 ^c
Water absorption index	3.80±0.05	3.25±0.02	3.50±0.00
Water solubility index (%)	10.02±0.25 ^a	10.22±0.18 ^a	9.74±0.08 ^b
Cutting strength (kg)	14.34±1.33	14.20±0.36	13.60±1.14

All the results are means of ten replicates; ^{a,b,c} Means with different superscript in a row differ significantly (P<0.05)

sum of DMI from concentrate and arhar straw. All the animals were fed with different pellet and arhar straw *ad libitum*. DM of feed sample was estimated by drying in hot air oven at 100±1°C until constant dry weight is achieved (AOAC, 2012). The duration of experimental feeding trial was 4 weeks. The data generated in the study is presented as mean. Data was analysed using ANOVA and means were compared using Duncan's multiple range test. The P value less than 0.05 was taken to indicate statistical significance by adopting standard statistical procedures (Snedecor and Chochran, 1989).

Physical properties of concentrate pellet of different diameter size are presented in Table 1. The SEI was slightly lower (1.139) for smaller size die (8 mm) and higher (1.172) for larger die (12 mm). A high

BD is associated with a low expansion index because more compact material is obtained after milling pellets. The BD measured was highest (1.174 g.cm⁻³) for smallest size (8 mm) pellet and lowest (0.794 g.cm⁻³) for biggest size (12 mm) pellet. The feed pellets of size 8 and 10 mm exhibited WSI in almost same range of 10.021 and 10.219 %. WSI was smaller (9.74%) for larger size pellet (12 mm). This could be due to increased temperature of ingredients passing through smaller size die increases WSI, due to increased solubility of starch molecules (Chakraborty *et al.*, 2009).

All the goats were fed individually with the concentrate pellet first and time of consumption was recorded. There was no impact of pellet size on the pellet intake of animals. During 1st week of feeding the consumption time (mins) of concentrate pellet was

Table 2. Effect of feeding different size of concentrate pellet in different groups of goats

Parameters	Gr I	Gr II	Gr III	Mean
Body weight (kg)	23.72±0.82	24.05±0.83	23.75±0.64	23.84±0.40
Pellet consumption time (min)				
1 st week	16.10±1.3 ^b	13.57±0.05 ^{bc}	21.46±3.21 ^a	17.04±1.44 ^a
2 nd week	13.85±0.17 ^{bc}	14.10±0.03 ^{bc}	15.57±0.64 ^{bc}	14.51±0.30 ^b
3 rd week	12.95±0.15 ^{bc}	13.30±0.13 ^{bc}	13.35±0.22 ^{bc}	13.20±0.10 ^{bc}
4 th week	12.50±0.14 ^c	12.17±0.09 ^c	12.14±0.05 ^c	12.27±0.07 ^c
Mean	13.85±0.46	13.28±0.18	15.63±1.18	14.25±0.44
DMI (g/day)				
Concentrate	380.00±0.00	380.00±0.00	380.00±0.00	380.00±0.00
Gram straw	315.99±5.26	318.28±5.51	312.50±5.79	315.54±3.14
Total	695.99±5.26	698.28±5.51	692.50±5.79	695.59±3.14

^{a,b,c} means with different superscript in a row differ significantly (P<0.05)

significantly ($P < 0.05$) highest in Gr III (21.46), followed by Gr I (16.10) and Gr II (13.57). Later in second week the time difference was less among groups. During 3rd and 4th week there was no significant difference in the consumption time of different size of pellets (Table 2).

The overall feed intake was also statistically similar in all the three groups of goats. Abdollahi *et al.* (2013) also reported that grain type and die hole diameter have little effect on pellet quality in birds but, increasing the pellet length improved pellet integrity. Therefore, pellet length, though not usually considered, can have a significant effect on pellet quality in birds. However, the feeding behaviour of poultry and ruminants are quite different. Goetsch *et al.* (2010) reviewed the factors influencing the feeding behavior of goats. They reported that grazing management practices, type of vegetation and season, breed and stage of production, group size, and properties of diets fed in confinement can affect the feeding behaviour of goats. Feeding behaviour was also influenced by level of concentrate in the ration (Lu *et al.*, 2008; Giger-Reverdin *et al.*, 2014) and physical characteristics of fiber, mainly particle size (Lu *et al.*, 2008) and dietary fibre intake (Lu *et al.*, 2008). However, in the present study the composition of pellet was similar in all the group and only there was difference of pellet diameter. So, the difference in feed intake as observed in this study was in the expected line. The animals have adopted the concentrate pellet in 2-3-week time and no significant difference was reported after adaptation period.

Present study concluded that diameter of concentrate pellet had no significant effect on its intake and overall DMI in goats.

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